

The enigma of lithium in roAp - CP stars. Some observational results obtained with different telescopes

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Abstract. The international Project “Lithium in magnetic CP stars” has been put into operation using telescopes of the Crimean Astrophysical Observatory (2.6-m reflector ZTSH), European Southern Observatory (1.4-m CAT and 1.52-m with FEROS), Mount Stromlo Observatory (74-inch), Nordic Optical Telescope Scientific Association (2.4-m with SOFIN), and Special Astrophysical Observatory of the Russian Academy of Sciences (6-m BTA). Here we present an historical report of the different scientific results of this project since its beginning in 1996.

Keywords. Stars: abundances, stars: chemically peculiar, stars: spots, stars: individual (HD 3980, HD 60435, HD 83368, HD 134214, β CrB, 33 Lib, HD 166473, γ Equ), stars: magnetic fields

1. The main stages of the Project and obtained results

The international project “Li in magnetic CP stars” appeared as a necessity to resolve several enigmatic problems related to the presence of lithium in the chemically peculiar (CP) stars. Systematic observations of classical Ap stars β CrB and γ Equ were started in the Crimean Astrophysical Observatory (CrAO) in 1991. The variability of the Li I 6708 Å line with rotation phase in the spectra of β CrB and non variable strong Li line in the spectra of γ Equ were discovered (Polosukhina *et al.* 1995; Hack *et al.* 1997).

In 1996 twelve CP stars were observed at ESO with the 1.4-m Coudé Auxiliary Telescope (CAT) and Coudé Echelle Spectrometer (CES) in the Li I spectral region (6675

– 6732 Å). The main result of these observations was the discovery of the variability in intensity and position of the Li I 6708 Å line profile in the spectra of HD 83368 and HD 60435. These variations were interpreted as the existence of two lithium spots on the surfaces of these stars. Strong and non-variable Li I lines were observed in the spectra of 33 Lib, HD 134214 and HD 166473 (North *et al.* 1998; Polosukhina *et al.* 1999). The parameters of the Li-spots on HD 83368 and HD 60435 and their Li abundances were determined using the codes STARSF and ROTATE written by V. Tsymbal (Polosukhina *et al.* 2000; Shavrina *et al.* 2001). The synchronism of the variations of the Li I line profile, light curve and magnetic field strength was explained in terms of the oblique magnetic rotator model.

The obtained results gave an impulse for new monitoring of the star HD 83368 in the broad spectral region (3650 – 9270 Å) with the spectrograph FEROS at the 1.52-m telescope at La Silla, ESO, in December 2000. Applying the multi-element abundance Doppler imaging inversion code INVERS12 permitted to recover surface distributions of 17 chemical elements, including Li, on the surface of this star. Li was found to be strongly concentrated at the magnetic poles, with $R_{\text{spot}} = 15\text{--}20^\circ$ (Kochukhov *et al.* 2004).

High-resolution ($R = 88\,000$) spectra of twelve CP stars were obtained during the observing run in September-October 2001 with the 74-inch telescope and Coudé echelle spectrograph of Mount Stromlo Observatory (Polosukhina *et al.* 2003). The most interesting result was obtained for the star HD 3980. This star shows strong variations of position and intensity of the Li I 6708 Å line with the rotation phase, similar to that of HD 83368. Detailed analysis of this star is presented in Drake *et al.* (2004), see also Drake *et al.* in this Symposium.

A new set of observations has been carried out with the 6-m telescope BTA (Big Telescope Alt-azimuthal) and Nasmith Echelle Spectrometer of the Special Astrophysical Observatory (SAO) of the Russian Academy of Sciences. First high-time resolution observations of γ Equ in the Li I 6708 Å spectral region have been carried out (Polosukhina *et al.* 2004a).

More detailed discussion of the results obtained in the course of the Project realization can be found in Polosukhina *et al.* (2004b).

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